HIGHLIGHTS '68

DEPARTMENT OF ENERGY, MINES AND RESOURCES, OTTAWA

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HIGHLIGHTS '68

The Department of Energy, Mines and Resources in 1968 gave renewed emphasis to programs aimed at promoting effective development, conservation and wise use of the country's energy, mineral, water and other natural resources for the continued growth of the national economy.

Canada's dependence on the mineral industry is substantial: the value of Canadian mineral production in 1968 amounted to $4,735,400,000 and accounted for 7.1 per cent of the gross national product and an estimated 30 per cent of the country's export trade.

To help maintain the rate of discovery of new mineral reserves to replace those being mined, the Department paid increased attention to the development of new techniques and new tools for prospecting and exploration. Cooperative work with Atomic Energy of Canada has resulted in new airborne equipment to assist in the search for uranium.

The Department stressed projects directed to the conservation of the country's mineral resources on a national scale in the face of the gradual depletion of many of Canada's ore deposits. These projects involve the development of new technology for the treatment of lower grade and refractory ores, new processes to convert uneconomic mineral resources into marketable products, and methods for solving the wide range of problems affecting Canada's metal industries. The newly developed apparatus for cleaning coal, the McNally Visman Tricone, now in commercial production, is based on departmental work in coal beneficiation.

Abundant supplies of fresh water are essential to meet burgeoning industrial, domestic and recreational demands.

In 1968 the Department expanded its pollution studies of the Great Lakes, extended its networks of water observation stations across the country, and began new basin and regional studies for water development, such as in the Qu'Appelle River Basin. The CSS LIMNOS, especially constructed for research on the Great Lakes, completed its first full year of operation.

On Canada's coasts, there is an urgency to ascertain the resource potential of the country's expanses of continental shelf.

In December 1968 the Prime Minister announced the federal government's intention of administering the offshore resources of its shelf and of sharing the revenues with the provinces. The Department administers these resources.

In a far-reaching oceanographic program, the Department prepared for HUDSON 70, a 41,000-mile expedition, which in 1970 will completely encircle the two Americas, passing through the Atlantic, Antarctic, Pacific and Arctic Oceans. A major purpose of the expedition is the geological and geophysical study of Canada's continental shelf on the three coasts.

New sources of energy must be developed to keep ahead of increasing national needs.

Much progress was made in the cooperative federal-provincial study of the feasibility of harnessing the power potential of the tides of the Bay of Fundy. At the same time, the Department is studying the implications of the recent discovery of oil in northern Alaska and the related exploration activity in northern Canada, one of the major resource developments in 1968.

Of great significance to the western coal industry was the signing of contracts in 1968 for the export to Japan of over 110,000,000 tons of western coal valued at $1,500,000,000.

As a service to industry, government agencies, universities and the public, the Department maintains institutes and offices in various strategic areas about the country. These are featured in this issue.

LAND-BASED PROGRAMS

MAPPING

Basic Mapping

Accurate topographic maps are a basic tool for resource development work and are essential to countless enterprises industrial, scientific and otherwise. After completing the topographical mapping of Canada's land areas on the 1:250,000 scale, the Surveys and Mapping Branch turned to the more detailed mapping of economically important hinterland areas and the revision of old maps made obsolete by the country's growth. The large-scale photo map, a relatively new product prepared by carefully mosaicing aerial photographs and overprinting essential cartographic detail, has proved most effective in meeting the urgent demand for maps of resource areas for which line maps have not yet been produced.

Control Surveys

Precise levelling (i.e. determining heights above sea level) is vital to many engineering and mapping projects; in 1968 the demand for this type of information reached record proportions. Departmental survey parties advanced 1,200 miles in the line of precise levelling being run along the 4,200-mile Trans-Canada Highway from coast to coast. They are placing permanent bench marks from one-and-a-half to two miles apart along the route. The project will be completed in 1970. A sidelight of scientific interest is the fact that the new elevations, when compared with those taken 30 to 40 years ago, will indicate movement in the earth's crust during that period.

Meanwhile topographers increased the density of survey marks in Prince Edward Island to assist the Atlantic Development Board in its land-use studies of the province and help provide a revised system for land ownership registration.

Aerodist Survey in Western Canada

Of inestimable value in survey work is "aerodist", a modern electromagnetic system which allows fast, accurate measurement of long distances from a specially-equipped airplane. In 1968 the method was applied over 150,000 square miles of northern Alberta and the Northwest Territories between latitude 56° and 63° and longitude 108° and 123°. Purpose of the survey — which involved a party of 46 surveyors — was to assist geophysical exploration and petroleum companies in locating the exact positions of their exploration permits and oil leases.

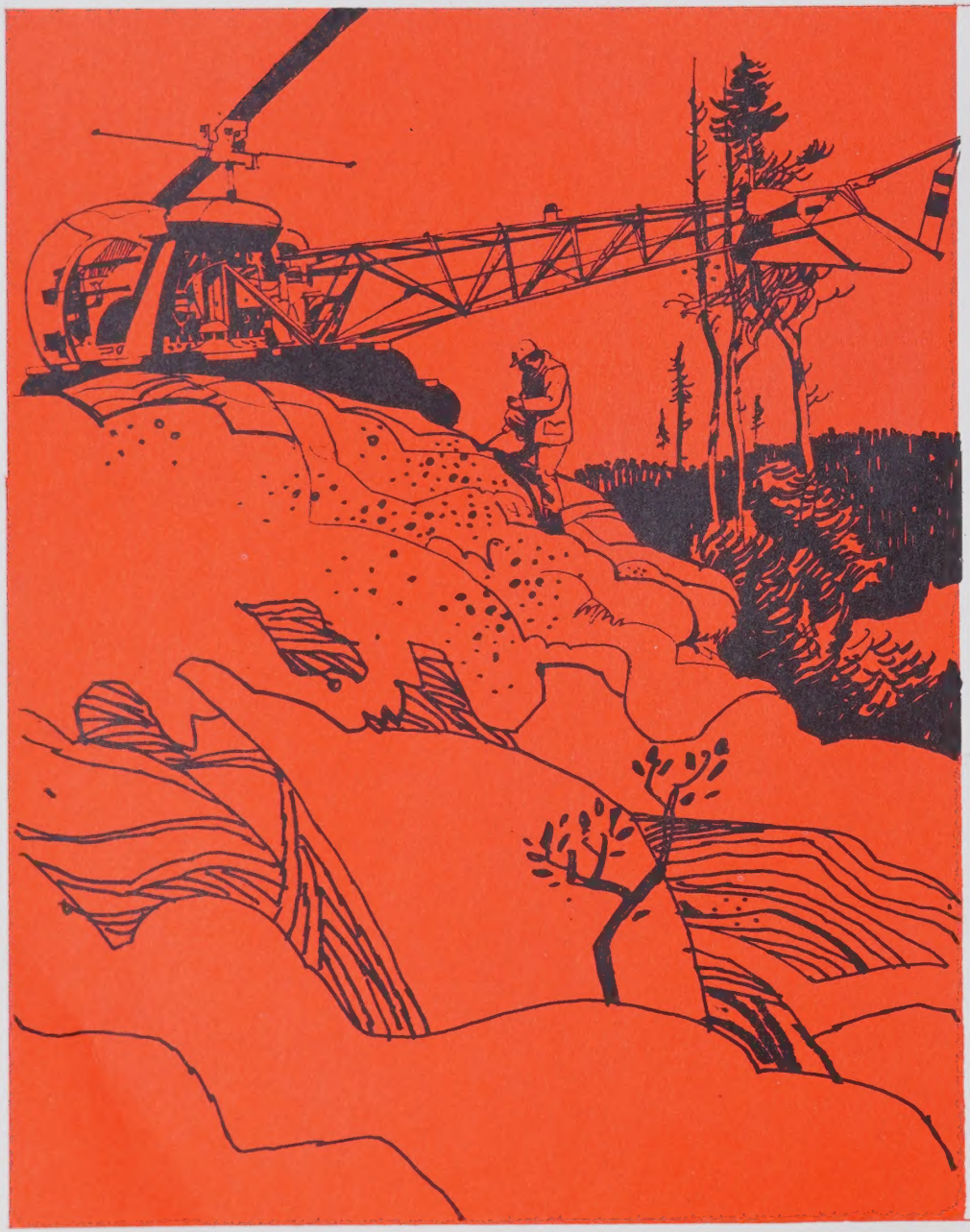
Assistance to Developing Countries

The Surveys and Mapping Branch continued to provide technical advice and engineering support to the Canadian International Development Agency (formerly External Aid Office) in topographical mapping projects in Tanzania, Nigeria, Trinidad, Guyana and Jamaica. It also provided practical training in surveying and mapping techniques to students from developing countries attending Canadian technological institutes and universities. One such course, a 12-week seminar, was attended by students from Africa and from Commonwealth countries of the Caribbean.

Maps, Air Charts, Air Photos

The demand for survey information continued to rise during 1968. Some 4,000,000 maps and 1,000,000 aerial photographs valued at more than $1,000,000 were sold during the year.

Two special maps were issued. The Atlantic Provinces Resources and Economic Activity Map shows all aspects of recent development and the commercial potential of this region and could be described as a single-sheet, economic atlas. The new Gravity Map of Canada, at a scale of one inch to 40 miles, was published in four sheets. This has already proved to be a most popular addition to Canadian mapping.



GEOLOGY AND GEOPHYSICS

The Geological Survey of Canada continued to provide the mineral industries with data and guidance to assist the exploration for and discovery of mineral deposits. The work of the Survey was also of importance to engineering projects and to the development of water supplies and other resources.

In 1968 some 100 geological field parties were at work in various parts of Canada.

Operation Norman, Northwest Territories

The year 1968 saw the completion of the first phase of a two-year geological reconnaissance of a 163,000-square-mile area between Great Slave Lake and the Arctic Coast in the Northwest Territories. The work was carried out by a 24-man party supported by three helicopters and a fixed-wing aircraft, with casual charter of a larger aircraft. Rocks in the area are promising as potential reservoirs of oil and gas and, in the northeastern part, may contain other minerals as well.

Anvil-Vangorda District, Yukon Territory

Geologists completed a two-year study of the Anvil-Vangorda District in Yukon Territory to help determine the area's full mineral potential. It contains three known major base-metal deposits, the largest of which is under active development. Cooperation between the Geological Survey and industry provided much geological information that will assist in the search for other deposits in the region.

New Tools for Exploration

Survey geophysicists made marked progress in developing instruments and methods to aid geological investigation and the search for new mineral wealth. In recent years they have pioneered in the detection and study of naturally occurring gamma rays and, in cooperation with Atomic Energy of Canada, have developed airborne equipment to assist in the search for uranium. Full-scale trials of the equipment were run in 1968 with considerable success.

Another project involved the use of two new electromagnetic survey methods AFMAG and VLF. These surveys, carried out under contract in northern Manitoba and Saskatchewan, delineate geological structures with which mineral deposits are often associated.

Geophysical Surveys

Cooperative federal-provincial aeromagnetic surveys were flown over almost 100,000 square miles in British Columbia, Newfoundland and in the northern territories, including parts of the Polar Continental Shelf and Baffin Island. The basic data assist the various governments in their geological investigations and serve industry as guides for prospecting. Over a million and a half square miles of territory have been covered by these surveys since the program began in 1962. Results are published in the form of maps issued simultaneously at various centres according to a prearranged schedule so that all concerned have an equal opportunity for making use of the information as soon as it is available. A recent issue of maps disclosed two major magnetic anomalies on Baffin Island, which will undoubtedly lead to further prospecting for iron during the coming field season.

Environmental Geology

The Geological Survey is paying increasing attention to the geological aspects of human environment: namely, the application of geology to such diverse fields as agriculture, town planning, construction, forestry and many other endeavors. Accelerated urbanization and resource development have generated a need for such studies as background for effective planning for future development and conservation of natural surroundings. In 1968 terrain investigations were conducted in the reservoir areas of the Columbia and Peace River dams where nature is being drastically modified by great engineering projects. The Survey is also investigating recent muds and bottom materials in Lakes Erie and Ontario as part of the Department's program of pollution research in the Great Lakes.

New Series of Maps

The first two maps of a new series at a scale of 1:5,000,000 were published in 1968. They were exhibited for the first time at the International Geological Congress in Prague where they attracted considerable interest. The whole of Canada is shown on each sheet. The first two maps deal with glacial geology and geomagnetism. Other sheets showing geology, tectonics, mineral deposits, and physiography will be published during 1969.

The Institute of Sedimentary and Petroleum Geology

The Institute of Sedimentary and Petroleum Geology at Calgary, Alta., is a modern research facility of the Geological Survey of Canada providing basic scientific information to industry and other government agencies and carrying out research into fundamental problems of geology.

Located in the headquarters of Western Canada's oil industry, the Institute investigates the bedrock architecture of the Western Plains and Arctic regions which lie between the Precambrian Shield on the east and the Cordillera on the west. These layered rocks are the hosts of Canada's large resources of oil, natural gas and coal.

A measure of the need for the Calgary Institute and its success lies in the continuing demand for information on the geology of the western provinces and of the territories.

Research by the Institute is providing data on the stratigraphy and the historical framework of these regions. A program, just beginning, is designed to further our understanding of how these rocks were formed, and of the accumulation and migration of petroleum and natural gas.

The scientific work is carried out by six research sections, comprising 33 scientific and professional staff, 19 technical staff and 13 administrative support staff.

The two-storey $2,500,000 structure was built in 1967 on a 15-acre site adjacent to the University of Calgary. It provides 90,000 square feet of floor space for offices, laboratories, research library and sample and core storage. Its excellent library is open to the scientific community and inter-library loans provide service to industry, other government agencies and to universities.

The Institute features a repository for samples from all wells drilled in Western Canada and for cuttings and cores from wells drilled in Yukon and Northwest Territories. The samples constitute an up-to-date library of basic geological information for industry and government scientists alike.

MINING, METALLURGY AND FUELS

The programs of research and development in the Mines Branch are aimed at diversifying and enlarging Canada's mineral resource base. The Branch is concentrating particularly on mining systems metallurgical processes, and the utilization of minerals, metals, and fuels. Its programs are planned to complement those of industry and the universities.

Silver-Cobalt Minerals

Research into the structure and behavior of minerals is important to the development of new and improved ore processing methods. In 1968 the branch had under way some 35 projects in this field.

A continuing comprehensive mineralogical investigation of the silver-cobalt ores from the Cobalt-Gowganda district of northern Ontario has succeeded in unravelling some of the complexities of these deposits. The Branch has found, for instance, that some of the ore veins exhibit a systematic zoning. This could mean that the higher the content or arsenic minerals, the higher the silver content is likely to be.

Electronic Ceramics

In the field of ceramics, branch scientists have devised a method of processing powder containing lead and zirconium and lead and titanium. For the manufacture of ceramics, these powders have more desirable firing characteristics than have available commercial products. The new process is being evaluated for its potential application to the production of ceramic transducers in North America.

Mining Research—Mining Systems Analysis

The Branch has initiated a promising new research program in mining methods. Here, data from Branch research programs and from actual mine operations are being used to design computer programs for solving a wide variety of practical mining problems. They may be relatively simple as, for example, the design of mechanical components, used in some part of the mine, or very complex, involving the whole mining operation and how to increase its efficiency.

Mining Research—Open Pit Mining

The amount of ore which can be recovered from an open pit mine depends, to a large extent, on the slope of its walls. The steeper the walls, the greater the recovery.

In 1968 the Elliot Lake Laboratory investigated the feasibility of applying artificial supports to achieve steeper slopes in open-pit mining. A prototype installation was made in an operating iron ore mine to obtain data on both the rock mechanics and construction costs of the system. Preliminary data suggest that significantly increased ore recovery and increased profits may be possible on some properties for example, from $5,000,000 to $10,000,000 over the life of a typical modern deep open pit.

Gravity Concentration

Branch research has resulted in a better understanding of the separation of minerals by agitation or "jigging". Development of these ideas has already resulted in new, more economical applications for this type of ore concentrating equipment. A new type of air-operated jig being developed should be particularly useful in mining areas where the supply of water is limited.

Electric Smelting

Since electric smelting is an important metallurgical technique in the Canadian mining industry, the Branch has given considerable attention to the development of a more efficient electric smelting furnace. It has designed a 250 KVA combination shaft-and-electric-arc furnace, in which the raw material is preheated and prereduced by hot gases before being introduced into the furnace. This results in a considerable saving of electric power. In addition, the system can ultimately be completely automated.

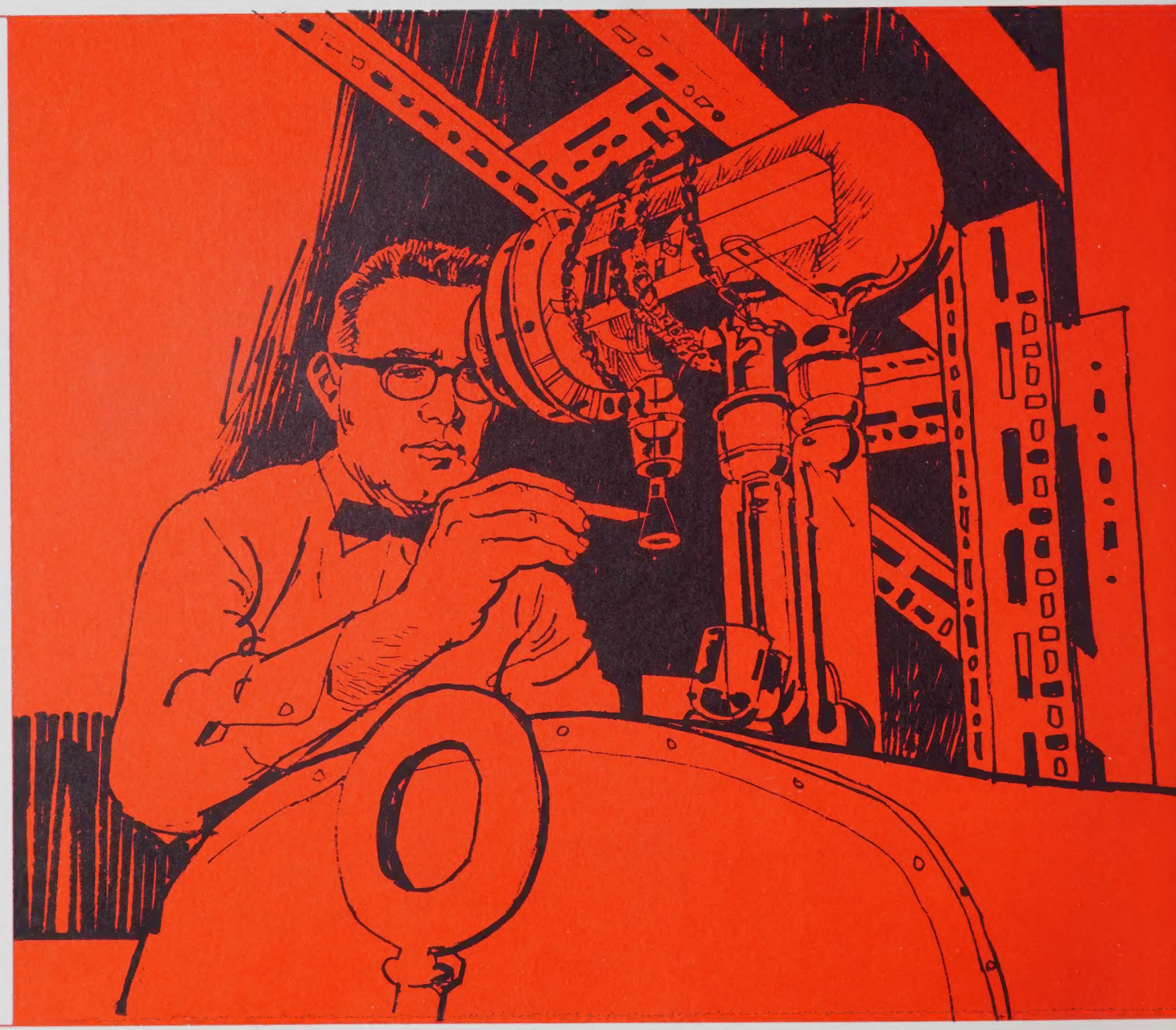
Steel Production

The Branch is continuing its work on a probe, currently in limited commercial production, for instantly measuring the oxygen content in molten steel. This is a significant breakthrough in steel-making and may bring about major improvements in both production costs and quality.

Coal Cleaning

The Mines Branch Fuels Research Centre has attempted to improve its coal cleaning and preparation facilities at the Centre's Western Regional Laboratory at Clover Bar, Alberta.

These are operated in the pilot plant laboratory of the Research Council of Alberta through co-operative arrangement between the Council and the Mines Branch dating back to 1952. The emphasis has been on the development of new mechanical separating devices to improve coal quality by eliminating mineral matter. This work has resulted in a new industrial-scale, coal-cleaning unit, the McNally Visman Tricone, which has demonstrated its superiority in large coal-cleaning plants in Australia. Branch scientists predict a bright future for its application in Canada.



The Mines Branch Elliot Lake Laboratory

The Elliot Lake Laboratory is an arm of the Ottawa-based Mining Research Centre of the Mines Branch which works with the mining industry in overcoming the many problems associated with modern mining operations. Established in 1964 adjacent to the Nordic Mine near the town of Elliot Lake in northern Ontario, the Laboratory carries out research and tests within the mine environment in three fields: ground control, rock breakage, and dust control.

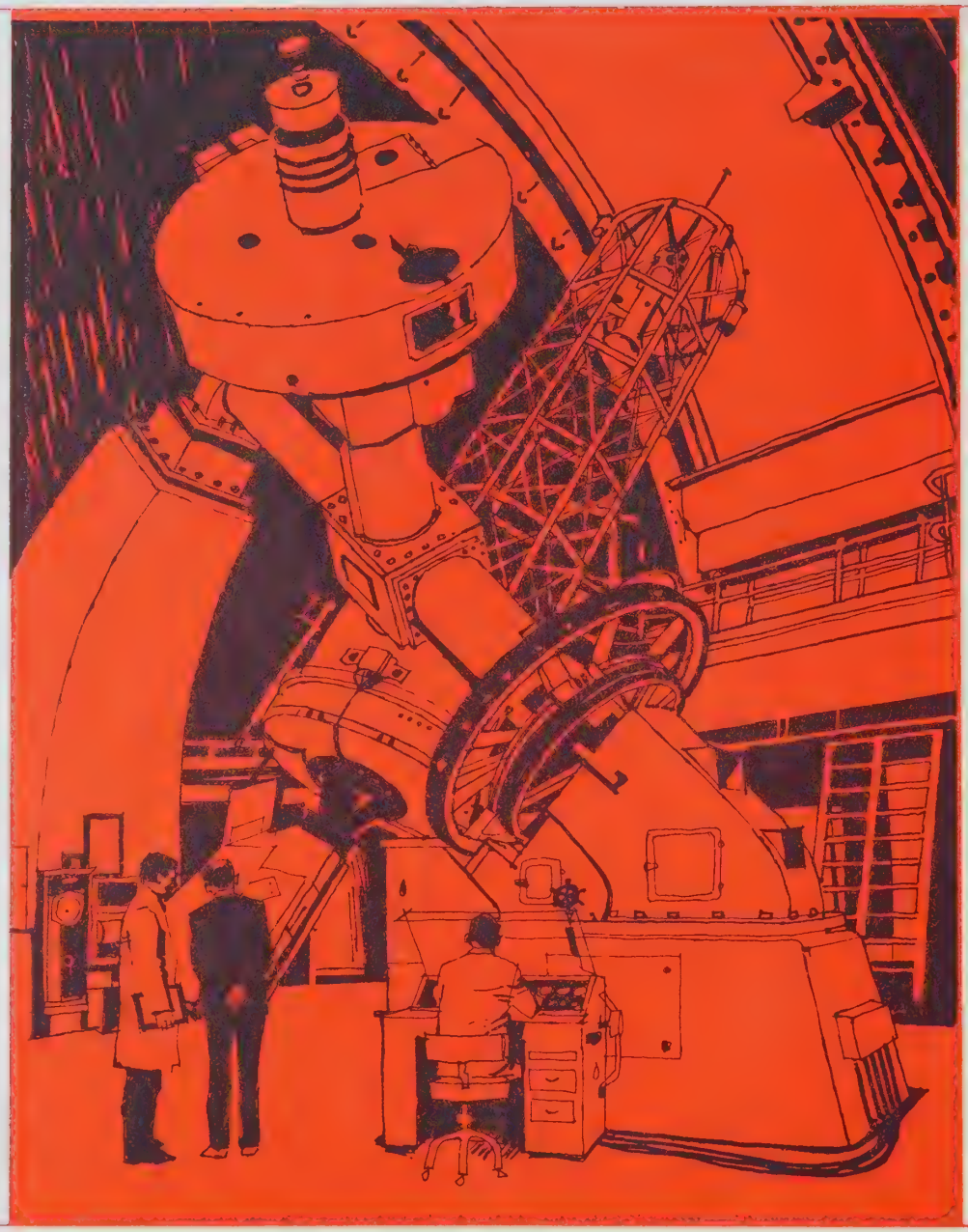
The proximity of the Laboratory to operating mines with their surface and underground facilities goes far in eliminating the restrictions imposed by laboratory simulation and distance and allows the research worker to test the conclusions of the theoretician, the experimentalist, and the experienced by direct measurement and in situ observations.

The Laboratory's ground control research involves primarily the gathering of numerical data from the mine or pit environment and is focused mainly on the behavior of pillars, rock bolts, fill, and pit slopes. Closely allied to this work are the cooperative studies carried out by the Laboratory and industry into specific mine problems, such as rockbursts.

In rock breakage, the Laboratory is studying the means of producing stress in rock and the behavior of rock under known stress. Its longer range studies are directed toward the development of novel ways of rock breakage, such as ultrasonic methods.

In dust control, the Laboratory has taken on the basic problem of relating the concentration indexes, derived from the various methods of sampling airborne dust, to the health hazard. It is also working on particle-size distribution and composition analysis of as received samples. Respirable size airborne dust, produced by mining operations, has been credited with causing diseases when accumulated in the lungs of miners. Control is primarily by keeping the concentration of these dusts below threshold limits.

The Laboratory staff numbers 30 of whom 23 are scientists and technical personnel engaged directly in research and development.



ASTRONOMY AND GEOPHYSICS

The services of the Observatories Branch in transmitting the time and providing data on the earth's gravity, magnetism and seismicity, and on star positions were in increasing demand for a host of enterprises, both commercial and scientific. In addition the Branch's studies of individual stars, interstellar clouds, the galaxy and outer space were contributing to man's understanding of the nature and size of the universe and the laws prevailing at great distances from our solar system.

Accurate Time

The most popular public service of the Observatories Branch is the noon day signal broadcast by the CBC and the continuous signal over the three short-wave channels of CHU. A bilingual voice announcement gives the time each minute of the day.

Continental Drift

Geologists and geophysicists are very much interested in the possibility that the continents may be drifting apart. Astronomy may provide proof. In 1968 a small observatory was opened near Calgary equipped with a photographic zenith telescope (PZT), an instrument which provides very accurate measure-

ments of the times at which stars pass directly overhead. The Calgary PZT is at exactly the same latitude as a similar instrument maintained by the Royal Greenwich Observatory at Herstmonceux, England. The two telescopes observe the same stars at a time difference corresponding to their difference in longitude. If continents are drifting, it should show by a change in this time difference. It is believed that evidence, one way or the other, should begin to emerge in about 10 years.

Radio Astronomy

One of the most exciting astronomical events in recent years is the discovery of "quasars" (star-like objects) — sources of radio emission which put out incredible amounts of energy but which seem to have relatively small diameters. The question is, "How small?" During 1968, Canadian radio astronomers observed simultaneously at Jodrell Bank in England, Algonquin Park in Ontario and the Dominion Radio Astrophysical Observatory at Penticton, B.C. Results from the Jodrell Bank-Penticton baseline, which is over 7,500 kilometers long, indicated that the angular diameters of certain quasars are extremely small. The puzzling question is, "How can so much energy be generated by such an apparently tiny object?"

Earthquake or Explosion?

A vital problem facing mankind is the control of nuclear armaments and the finding of some way to recognize clandestine underground testing. Instruments at Yellowknife, NWT, can help solve this problem. The branch has established an "array" of 19 seismometers laid out on two 14-mile lines which operate in conjunction with the Canada-wide network of 25 standard seismograph stations. By comparing earthquake waves and those produced by explosions in the same general area, methods have been devised to positively identify explosions down to a TNT-equivalent of a few kilotons in hard rock.

Magnetic Charts

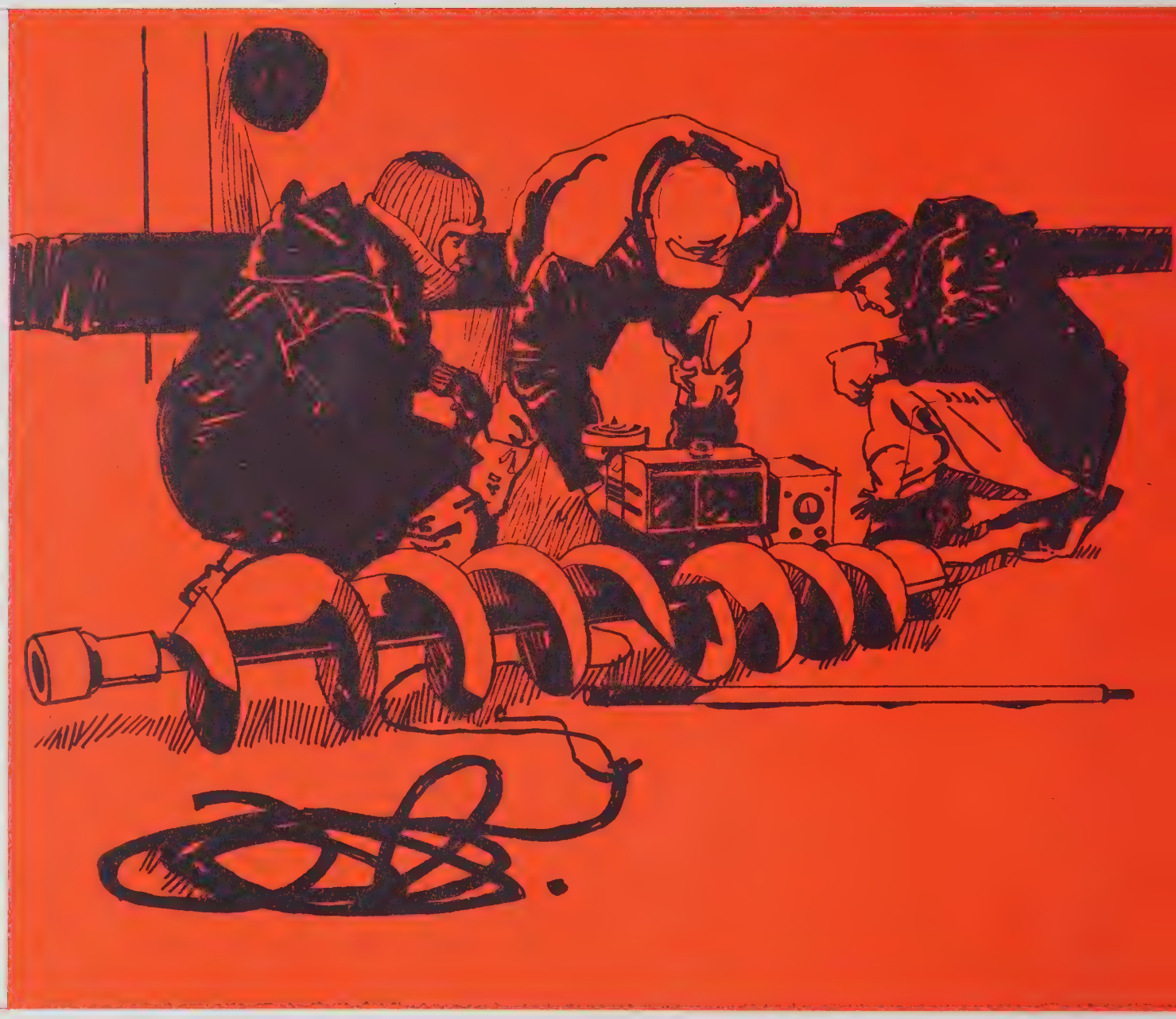
Information about the earth's magnetic field is necessary for prospecting, navigation, telecommunications and a great variety of other endeavors, scientific and technological. In 1968 the Observatories Branch opened a new magnetic observatory at Blackburn, near Ottawa, bringing the total number

of such observatories in Canada to 10. In 1968 magnetic mapping was continued. An airborne magnetic survey over the Province of British Columbia and a 200-mile-wide strip over Pacific coast waters will begin in 1969.

The Branch's laboratory at Blackburn opened in May. In addition to a magnetic observatory and well-spaced buildings for instrument development, it provides advanced facilities for studying the ancient magnetic properties of rocks — research that is vital to many aspects of geology and mineral exploration.

Gravity

The Branch has developed, as a natural sequel to its new Gravity Map of Canada, a comprehensive system for storage and retrieval of gravity data by computer. It can thus provide better service to those in industry and science who use Observatory data.



The Dominion Radio Astrophysical Observatory

The Dominion Radio Astrophysical Observatory is devoted to the study of astronomical problems by means of radio techniques. Officially opened in 1960, it is in an isolated valley in British Columbia about 15 miles south of Penticton on a site selected primarily for its freedom from man-made interference.

Developed during the past two decades, radio telescopes have provided new information about familiar astronomical bodies and have helped discover strange remote galaxies hitherto unknown. The Penticton Observatory operates three major telescopes. The main instrument is 84 feet in diameter.

The study of radiation from atomic hydrogen gas, which is believed to comprise about three per cent of all the matter in the galaxy, is one of the most important branches of radio astronomy and one of the major programs at the Penticton Observatory. Scientists can determine the structure and internal motions of the galaxy from the measurement of gas velocities in many different directions.

The Observatory is designing a new and more flexible type of antenna. It will consist of two "dishes", mounted on an east-west railway track built with extreme precision. Ultimately a third "dish" running on a north-south line will be added to make a T-formation. This will provide a three-dimensional picture of radio sources in the sky.

The Observatory also has a solar telescope, a duplicate of a telescope which has been in operation for some time at the Algonquin Radio Observatory in Ontario. It is used to increase the time during which the sun is kept under continuous observation.

The Dominion Astrophysical Observatory

The Dominion Astrophysical Observatory is located a few miles north of Victoria, B.C., on a site selected for the qualities of clear sky and steady atmosphere required for the efficient use of a large telescope. At the time of its completion in 1918, its 72-inch telescope was the largest in the world.

The main tasks of the Observatory are the determination of the physical and chemical nature of the stars, and the measurement of the speeds and distances of stars. This information is used to study the shape, size, and structure of our galaxy and to investigate the origin of the elements, the generation of nuclear energy in the stars, and the origin and evolution of the sun and other stars.

The primary equipment consists of two reflecting telescopes the 72-inch one and one of 48 inches aperture, installed in 1962. Both telescopes are equipped with powerful spectrographs for the analysis of starlight, and accurate photometric apparatus for the measurement of the brightness and colors of stars.

New instrumentation was developed for the spectrographs attached to both telescopes and put into operation during 1968. This has effectively increased the speed of the instruments, and Observatory scientists have undertaken new far-reaching programs which will add to our knowledge of individual stars and improve our picture of both the galaxy and the universe.

During 1967-68, the 72-inch telescope was used on 175 nights and the 48-inch on 164 nights with a total of 1,248 hours of usable clear sky, rather more than average over the past 10 years and nearly equal to the average of the 50 years of observing at Victoria.

More than 32,000 persons visited the Observatory weekdays and Saturday evenings during public observation periods in 1968 to see the 72-inch telescope in operation and to look through it at selected astronomical bodies.

The Observatory also has extensive seismological and geomagnetic installations used for recording and studying earthquakes and the earth's magnetic field.

THE POLAR CONTINENTAL SHELF PROJECT

Eighty-five engineers and scientists of various disciplines carried out 27 investigations in the high Arctic between March and October 1968 under the Polar Continental Shelf Project. Basic to the assessment and ultimate development of our far northern resources, PCSP involves a continuing study of the Canadian Arctic Islands and the adjacent part of the Arctic Ocean. In 1968, specialists in various fields ran hydrographic, gravity, and Decca calibration surveys from a camp on a large ice floe in the ocean, 150 miles off Prince Patrick Island, and hydrographic and gravity surveys in Baumann Fiord, Ellesmere Island. They completed an aeromagnetic survey of some 55,000 square miles of the Arctic Ocean west of Prince Patrick Island and made repeated aerial surveys of the distribution of sea ice in all the main channels of the archipelago.

Other investigations included the measurement of geothermal heat flow through the ocean floor and at the bottom of deep lakes in the Arctic Islands; the study of sea bottom sediments near Melville Island; the measurement of magnetic characteristics of the earth at a number of stations north of the magnetic pole, and palaeontological and glacial geology studies in various parts of the archipelago. Mould Bay on Prince Patrick Island was the main base of operations.

Parties completed the control topographic surveys in the Beaufort Sea region, established and calibrated an electronic survey and navigation network in the Mackenzie River delta area, and built a main base camp at Tuktoyaktuk, NWT, in preparation for a future concentration of surveys and research in that region. The decision to prepare for detailed work in the Mackenzie delta-Beaufort Sea area, made in 1966-67 in anticipation of the early increase in petroleum development activity in this region, proved well founded. As a result, substantial service can be given in the surge of petroleum exploration and development planned by commercial companies in this area for 1969, following the 1968 discovery of a major oil deposit at Prudhoe Bay, Alaska, on the Arctic coastal plain just west of the Canadian border.

Field support was provided in 1968 to Arctic research programs conducted by the National Museum, the Department of Agriculture, the Defence Research Board, and seven Canadian universities.

WATER-BASED PROGRAMS

The Water Group comprises three Branches: the Inland Waters Branch, the Policy and Planning Branch and the Marine Sciences Branch.

Four new survey and research ships completed their first year of service: the CSS PARIZEAU and CSS VECTOR, on the west coast, CSS DAWSON on the Atlantic Coast, and CSS LIMNOS on the Great Lakes.

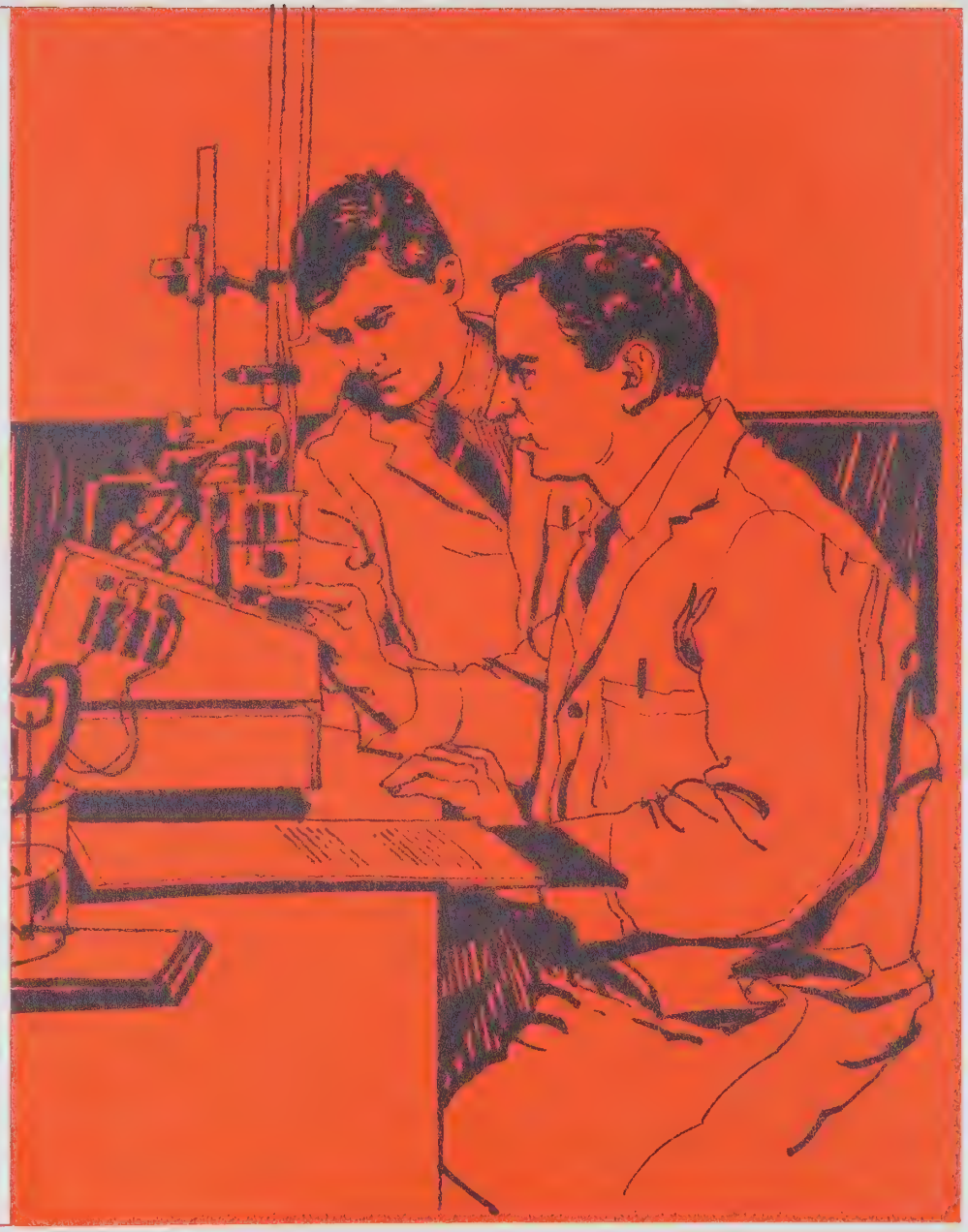
INLAND WATERS

Pollution in Lakes Erie and Ontario

The Inland Waters Branch prepared large sections of the report for the International Joint Commission on the pollution of Lakes Erie and Ontario, which had been requested late in 1964 by the governments of Canada and United States. Under the terms of reference laid down, the Commission was to investigate and report on the extent, causes, locations and effects of pollution in the waters of Lakes Erie and Ontario and the International Section of the St. Lawrence River and to recommend the most practicable remedial measures which might be considered necessary. The Branch's submission included reports on thermal regimes, circulation and trans-boundary movements of pollutants, oxygen depletion in the lakes, nutrient concentrations, and concentrations of major ions and trace elements.

Lake Ontario Sediments

A little known but key factor in the cycling of polluting substances in the Great Lakes is the role that the sediments play in trapping and releasing chemicals. The Inland Waters Branch has under way an intensive field program to determine the nature, rate of deposition and



chemical composition of Lake Ontario sediments. This is supported by laboratory studies of the interchanges of polluting substances between lake waters and the underlying sediments.

Appraisal of Northern Ontario Rivers

In 1968 the Branch completed its third season of field investigations and related studies of the water resources of northern Ontario. These consist of topographic surveys of possible dam sites, drilling and seismic surveys to determine foundation conditions and surveys to locate suitable construction materials and possible diversion routes for redistributing the water. The results of the field surveys are being used in the preliminary design and cost estimating of dams, spillways and diversion channels. The studies are being coordinated with provincial government studies and are expected to be completed in 1970.

Stream Pollution from Mining Operations

Emphasis continued to be placed on the abatement of pollution from industrial wastes, particularly from mining and milling operations. In New Brunswick, scientists stepped up their study of stream transport of pollutants from base metal mines, including on-site sampling and analyses — a program which will lead to better methods of pollution treatment and control. The work was assisted by laboratories in Moncton and Ottawa.

Groundwater Studies

The Inland Waters Branch, together with the Ontario Water Resources Commission and the United States Geological Survey, has begun a study of groundwater inflow into Lake Ontario. This is part of a major hydrological assessment of Lake Ontario in the context of the International Field Year on the Great Lakes. The study involves calculations of regional losses by evaporation and plant transpiration and the development of computerized maps.

Water Survey Network

The Water Survey of Canada operated a network of some 2,100 water level, streamflow and sediment transport stations throughout Canada for the collection of surface water resource data. Of these, 1,750 provided both water level and streamflow data (85 provided sediment transport data as well) and 350 furnished water level information only. This information is used by all levels of government, private industry and by countless individuals concerned with the assessment, design and development of projects for the utilization of Canada's resources.

Water Quality Network

The Canada-wide water-quality network, which was initiated in 1965 as part of the International Hydrological Decade program, was expanded in 1968 from 175 to 225 stations. The Branch also enlarged its study of the physical and chemical quality of water to provide more information on trace elements, including inorganics and other pollutant indicators, and other data requested by provincial and other agencies.

Qu'Appelle River and Okanagan Basin Studies

An ad hoc committee of representatives from Saskatchewan, Manitoba and the Department considered the need for and the scope of a comprehensive study of water resources of the Qu'Appelle River Basin. Pressing problems on the Qu'Appelle River include flooding, pollution and recreation, and the potential development of the river as a major channel to the

Assiniboine River. The committee's report was completed in October and is under review.

Plans were discussed in 1968 for a comprehensive study of the water resources of the Okanagan Basin by the British Columbia and federal governments with the aim of improving both the quantity and the quality of water in this dry interior region.

Atlantic Provinces

The Department played a major role in the Atlantic Development Board's water study for the Atlantic Provinces. It embraces the many uses of water, present and future water demands and water resources development in relation to other regional goals.

Agreement for Flood Control, Lower Fraser River Valley

The governments of Canada and British Columbia concluded a 10-year agreement for a flood control program for the protection of the Lower Fraser River Valley. The purpose of the program is to prevent flood disasters like that which struck the area in 1948, virtually severing southwestern British Columbia from the rest of Canada.

Under the agreement, Canada and British Columbia will each spend up to $18,000,000 on the planning and construction of flood control works on the Fraser River and four smaller streams: the Coquitlam, Vedder, Nickomekl and Serpentine Rivers. Local authorities will also contribute to the cost of projects from which they will benefit.

Resource Ownership and Allocation Studies

Branch geographers are working on the physical and socio-economic aspects of resource development. Since 1965 several pilot studies have been undertaken within various areas of Prince Edward Island and Nova Scotia. A more extensive two-year research program is now under way on Prince Edward Island in conjunction with FRED-ARDA, ADB and other federal and provincial agencies.

National Advisory Committee on Water Resources Research

The National Advisory Committee on Water Resources Research was established to provide funds to expand research in water resources, with the two-fold purpose of developing knowledge and expertise on water-resource problems by university staff and providing opportunities for graduate students to undertake work in this field. The Department, on the recommendation of NACWRR, awarded $349,705 to 49 applicants at 12 universities to conduct research in the natural and social sciences in 1968.

The Canada Centre For Inland Waters

The Canada Centre for Inland Waters at Burlington, Ontario, is being established as a multi-disciplinary centre for water studies by three federal agencies: the Department of Energy, Mines and Resources, which has played the leading role in developing the programs and plans of the Centre, Fisheries Research Board, and the Department of National Health and Welfare.

Permanent building plans, site development and the land survey were completed in 1968. Construction of the Centre will start early in 1969 and completion is expected in 1972.

The Centre is being designed to house from 250 to 300 scientists and their support staff. Total construction and equipment costs are estimated at $23,500,000. Provision is being made for active participation by universities and the private sector in the work of the Centre. Laboratory and office space is being provided for extensive use of the Centre's facilities by professors and graduate students. Facilities also will be made available to the private sector. Industry and consultants will undertake, un-

der contract, portions of the overall research. An advisory committee consisting of representatives from government agencies, industry and universities will participate in the planning of the work carried out at the Centre.

Meanwhile, the Inland Waters Branch and the Marine Sciences Branch of the Department of Energy, Mines and Resources and Fisheries Research Board are conducting active programs of Great Lakes research from a 25,000 square foot temporary trailer complex at the Burlington site. The LIMNOS, a 147 foot, 650-ton research vessel, the first built for Great Lakes studies, was put into service in May 1968 and is based at the Centre.

Scientists at the Centre have made major contributions to the forthcoming report of the International Joint Commission on pollution in Lakes Erie and Ontario. The study has been carried out in close collaboration with the Ontario Water Resources Commission and federal and state agencies in the United States.

CHARTING

Coastal

Charting activities of the Canadian Hydrographic Service of the Marine Sciences Branch ranged from reconnaissance surveys in the Arctic to very detailed harbor surveys to assist shipping, fisheries, mineral exploration and exploitation and other sectors of the economy. Hydrographers from the Branch's Atlantic Oceanographic Laboratory, Dartmouth, N.S., made detailed surveys of the southern approach to the Strait of Canso and to the harbor at Come by Chance, Nfld., and charted the harbor at Ile-aux-Morts to assist in the establishment of a large herring reduction plant. On the Pacific coast, a party from the Service's Victoria office surveyed the site of the Roberts Bank deep draft port near Vancouver, B.C.

Inland

Surveys were completed in two of Canada's most popular recreational boating areas: the sheltered passage and adjacent inlets through Georgian Bay's 30,000 Islands from Port Severn to Parry Sound, and the 240-mile Trent-Severn waterway. Charts of these areas afford recreational boaters some of the world's finest fresh-water pleasure cruising.

COASTAL WATERS

Investigations in the Caribbean area

The Atlantic Oceanographic Laboratory and the Marine Ecology Laboratory of Fisheries Research Board at the Bedford Institute carried out a fully integrated cruise to the Carribbean Sea aboard CSS HUDSON in 1968. Purpose of the cruise was to pursue, in this region, marine science studies already in hand in the North Atlantic and on the continental shelf adjacent to the coast of Eastern Canada. Scientists aboard investigated certain geological, biological, and oceanographic aspects of the Grenada Trough and southern Windward Island area; collected data on a north-south section through the western North Atlantic, and took samples of geological formations at various localities in the Lesser Antilles and South and Central America. Scientists from Canadian and American institutes and universities, the National Museum of Canada, and from Venezuela also took part in the cruise, working on independent projects.

Ocean Circulation Studies

Physical oceanographers, studying fundamental physical processes in the oceans and the properties of major current systems, expanded their programs in 1968 to include other aspects of wave action. The studies covered a wide area, extending to the Caribbean Sea.

Hydrographic-Geophysical Survey

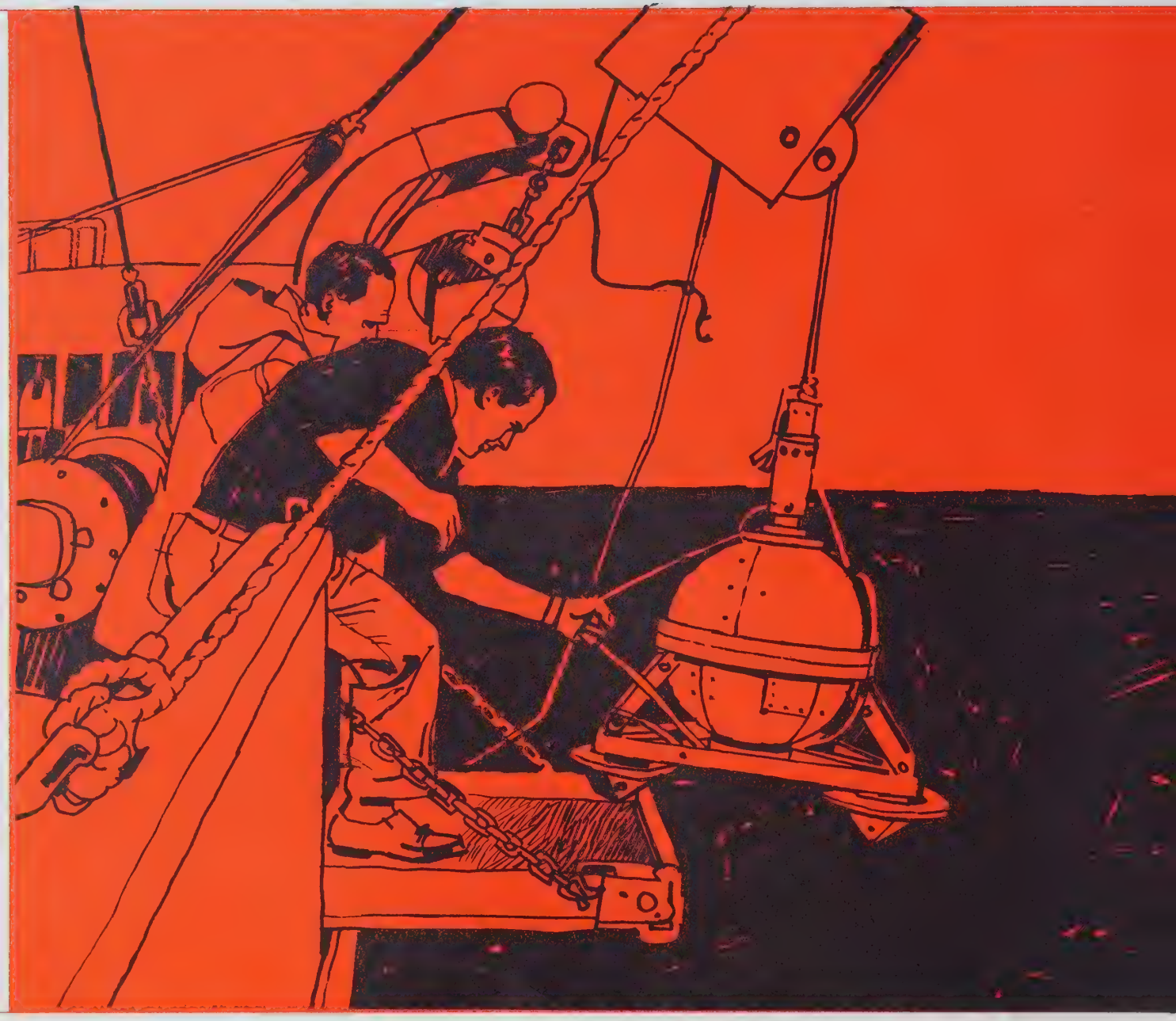
The Canadian Hydrographic Service began a combined hydrographic-geophysical survey of the Gulf of St. Lawrence off the west coast of Newfoundland. The use of advanced electronic techniques, such as LAMBDA, which proved so effective on the Grand Banks of Newfoundland, enabled the hydrographers to make the first detailed survey of the area. Results will be used to provide improved navigation charts, a better knowledge of the geophysical characteristics of the sea bed and, eventually, a series of natural resource charts.

Rock Core Drill

Oceanographers are continually improving their sea-bottom sampling methods. For instance, the Atlantic Oceanographic Laboratory has developed a deep-sea, self-contained rock-core drilling unit, utilizing the hydrostatic pressure of the surrounding water. The drilling unit was designed to obtain cores of solid rock, as opposed to soft, recent sediments, at precisely defined positions in deep water. It can be used in from 1,500 to 6,000 feet (455 to 1830 m) of water and, depending on the depth, can drill up to one meter of rock. Still to be overcome is the problem of soft sediment overlying the bed rock.

HUDSON 70

Plans for HUDSON 70, Canada's first oceanographic venture on a world-wide scale, were made in 1968. The Canadian Scientific Ship HUDSON will set out from Halifax in November 1969 on a one-year expedition of 41,000 nautical miles and completely encircle North and South America. Aboard will be scientists from the Department and other federal agencies, Canadian universities, and American oceanographic institutes and universities. Investigations will range from ocean circulation studies to geological and geophysical surveys of Canada's continental shelf on its east, west and northern coasts and will include biological, chemical and other oceanographic studies. The proposed expedition is evidence of Canada's increasing competence in oceanographic research and of her growing contribution to international studies of the world ocean, which have been strongly urged by international bodies, especially the United Nations.



The Atlantic Oceanographic Laboratory

The Atlantic Oceanographic Laboratory (AOL) is a division of the Marine Sciences Branch and is located in the Bedford Institute at Dartmouth, N.S. It serves as the Atlantic coast centre for Canadian activities in hydrography, oceanography, geophysics, chemistry and geology for the Atlantic and sub-Arctic regions.

AOL activities include geophysical and geological investigations of the deep structure of the continental shelves and of the floors of the deep ocean to ascertain the mineral resource potential of these regions; studies of oceanic and coastal circulation to better understand the means of transport of water properties and the dynamics of mixing processes in the oceans in the interests of fisheries and defence and in the assessment and prediction of pollution; studies of waves for application in harbor and breakwater design, navigation, and to tidal-power problems, and air-sea interaction studies to facilitate wave prediction and to improve weather forecasting.

The great interest in the mineral wealth, particularly oil and gas, of the continental shelf has led to very close consultation between exploration companies and AOL marine geology and geophysics groups.

An important, and increasing, part of the work at AOL is directed towards specific practical applications. For instance, during 1968 a study was completed, at the request of the National Harbours Board, of the wave and swell characteristics of Halifax harbor relative to the establishment of container-shipping handling facilities in the port. AOL has assisted the staff of the Atlantic Tidal Power Development Board in its study of the tidal power potential in the Bay of Fundy, and it has undertaken studies to help in pollution control in Pictou and Halifax harbors and in the Strait of Canso. Several longer-range projects which will ultimately help the fishing industry, have been started with the staff of the Marine Ecology Laboratory of Fisheries Research Board, which is also housed in Bedford Institute.

AOL plays an important role in the local scientific community. There is close cooperation between AOL and the Institute of Oceanography at Dalhousie University (IODAL). Several AOL staff members give courses at the university and graduate students at Dalhousie and other universities use AOL facilities for their research.

Victoria Office (Marine Sciences)

The Victoria Office carries out hydrographic surveys and tidal current investigations in Pacific and western Arctic waters, and charts inland navigable waters in British Columbia and the Athabasca-Mackenzie waterway. It distributes charts and related navigational data on Pacific and inland waters.

The Office's fleet comprises the CSS WM. J. STEWART, PARIZEAU, MARABEL, VECTOR and RICHARDSON. With the commissioning of the PARIZEAU late in 1967, the Canadian Hydrographic Service has been able to expand its program of tidal and current surveys in the Strait of Georgia. The research vessel VECTOR is used mainly by the Institute of Oceanography, University of British Columbia, for research projects in Pacific waters.

MINERAL ECONOMICS

The Mineral Development Group continued to carry out broad economic and commodity studies and to gather in-depth data, domestic and world wide, on both minerals and their markets. The resultant information serves both industry and government.

Regional Mineral Development

A study was made of the mineral resources of Nova Scotia at the request of the Atlantic Development Board. The resultant report, *Mineral Resource Development, Province of Nova Scotia,* is the third in a series of comprehensive regional studies of the Atlantic Provinces; the previous two studies cover Newfoundland and New Brunswick.

At the request of the Manitoba Targets for Economic Development Commission, a study was made of the outlook for the Manitoba mineral industry to 1980 for use in assessing development, outlook and policies for the entire Manitoba economy to that date. The study included an analysis of 1) the potential for future resource development, 2) the present and future position of producing companies in national and international markets, 3) the effect of mineral land tenure systems and mining regulations on capital expenditures for exploration, development and production, and their comparison with land systems and mining regulations elsewhere, and 4) the provincial organization for minerals administration.

International Mineral Activities

The Department continued active participation on behalf of Canada in a number of international agencies. For the International Lead and Zinc Study Group, it made a study of the combined occurrence of lead and zinc in complex ores throughout the world to ascertain the possible effect of production controls on one or more major metals on associated metals. For the European Nuclear Energy Agency, it prepared, in collaboration with Eldorado Nuclear Limited, a report on the future uranium production capability of Canada. For the Second United Nations Inter-Regional Symposium on the Iron and Steel Industry, departmental specialists prepared a paper, *Steel Plant Location in Developing Economies: A Canadian Viewpoint,* to assist developing countries in the developing of primary iron and steel industries.

Gold Mining Assistance

Cost-aid assistance to Canadian gold mines, begun originally in 1948, continued under the Emergency Gold Mining Assistance Act. The subsidy assists dependent communities to adjust gradually to the decline of the industry. Since 1948 the number of gold mines in Canada has declined from 87 to 39, of which 35 received assistance during 1968. Total payments for the fiscal year 1968-69 are expected to amount to $14,800,000. Although the number of gold mines continues to decline because of declining ore reserves and rising costs, the annual cost of assistance remains relatively constant owing to higher operating costs at producing mines.

Mineral Transportation

An analysis was made of the quantity of iron ore which can be expected to move through the St. Lawrence Seaway, and the effects that increases in seaway tolls and Welland Canal charges could have on the competitiveness of Canadian iron ores in their major United

States markets. The study was conducted for the Department of Transport. It included an examination and evaluation of mine production costs, the effect of changing raw material and processing technology on steel costs, and a discussion of the competitive position of alternative sources of iron ore in the steel markets of the Great Lakes area of Canada and the United States. The study was also useful in examining the need for an increase in canal capacity.

ENERGY

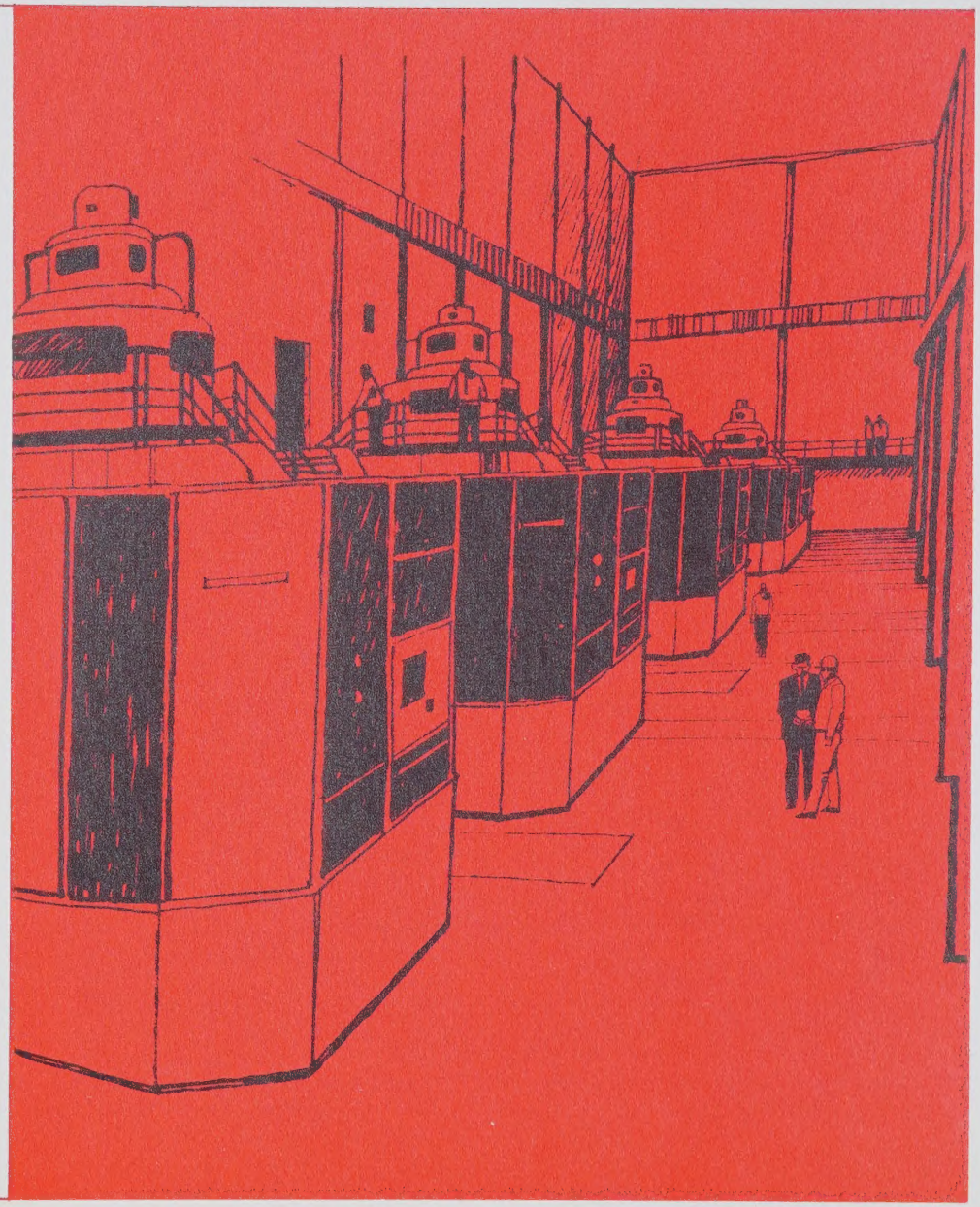
As coordinator in energy matters, the Energy Group was involved in developments in coal, oil and gas, uranium and electrical energy.

The Canadian Coal Industry

The Group is participating in the government-industry program designed to lead, in the early 1970's, to a revitalized Canadian coal industry. The latter is in a major period of transition from a high-cost, heavily subsidized industry serving the domestic market to one exporting large quantities of coal from new, efficient mines in Western Canada. An important phase is the rationalization of Maritime coal operations to make them less dependent upon federal financial support.

Northern Oil Development

The announcement in August 1968 of a major oil strike in northern Alaska greatly increased industry activity in that region and in the northern slope and the Arctic Islands of Canada. The size of discoveries in the north and the routes selected for deliveries to continental markets will have a major impact on the Canadian oil industry. The Department is heading



an inter-departmental task force to coordinate federal studies of the effects on the Canadian economy.

Offshore Petroleum Exploration

The tempo of offshore exploration activity reached an all-time high in 1968. Industry spent over $18,000,000 on offshore Canada oil and gas permits compared with $12,500,000 in 1967, $10,500,000 on geophysical and other surveys, and $8,000,000 on drilling.

The extensive oil-drilling program, set under way in mid 1967, is expected to continue through 1969. It features a semi-submersible drilling unit built in Victoria at a cost of $10,000,000, the largest such unit in the world. A similar unit is under construction in Halifax for use in a program off the Atlantic coast, which will probably begin in the latter part of 1969 and a second unit is to be constructed during 1969 for use in 1970.

More than 4,000 Canada oil and gas permits, covering over 300,000,000 acres were held at the end of 1968, compared to less than 3,000 covering 220,000,000 acres at the end of 1967. Of this, about 190,000,000 acres are off the east coast, about 95,000,000 are in Hudson Bay, and 16,000,000 are off the west coast. Revenues from offshore permits in 1968 were in excess of $300,000 and approximately $16,000,000 was held in the form of deposits to guarantee the fulfillment of permit work requirements.

Nelson River Power

Design and construction work proceeded in the cooperative federal-provincial development of the power potential of the Lower Nelson River in Manitoba and on the high voltage direct current transmission system required to deliver its output to Winnipeg. Atomic Energy of Canada Limited, on behalf of the Government of Canada, is constructing the ±450,000 volt transmission system which is designed to have a capability of 5,000,000 kilowatts in its final stage. A review committee has been established with federal representatives from the Department's Energy Group, Atomic Energy of Canada Limited, and the National Energy Board, to review the economic development, transmission and sale of Nelson River power, both within and outside Manitoba.

Columbia River Treaty

The Arrow Lake Dam, the second of three Canadian dams in the Columbia River basin, was placed in operation in October, approximately six months ahead of schedule. The third dam at Mica Creek is scheduled to be placed in service in 1973. The Department is represented on the international Permanent Engineering Board responsible for ensuring that all requirements of the treaty are properly discharged.

Study of Power Development from Bay of Fundy Tides

The study of the tidal power potential of the Bay of Fundy by the Atlantic Tidal Power Programming Board and its Engineering and Management Committee, both chaired by representatives of the Department, was extended from December 31, 1968 to June 30, 1969, and the authorized study cost was increased from $1,500,000 to $2,500,000 under the joint federal-provincial agreement. Preliminary assessment of possible power sites in the Bay, completed early in 1968, made it apparent that a comprehensive analysis of the more likely sites would require further field studies and research into production and marketing problems. This second phase of the project was well under way by the end of the year.